We Claim:

1. A nanoengineered structure comprising:

a one-dimensional nanoelement of a first crystalline semiconducting material having a first bandgap,

an enclosure comprising at least one second material having a second bandgap enclosing and in contact with said nanoelement along at least part of its length,

said second material being doped to provide opposite conductivity type charge carriers in respective first and second regions along the length of the of the nanoelement,

whereby corresponding first and second regions of opposite conductivity type charge carriers are created within the nanoelement with a pn junction therebetween by transfer of charge carriers into said nanoelement, and wherein the bandgaps are such that it is energetically favorable for the charge carriers to remain in said nanoelement.

2. A structure as claimed in claim 1, wherein the nanoelement comprises a nanowhisker upstanding from a substrate.

3. A structure as claimed in claim 1, wherein said enclosure comprises a coaxial jacket

4. A structure as claimed in claim 1, wherein the enclosure is an encapsulating matrix.

5. A structure as claimed in claim 1, wherein said at least one second material comprises a semiconductor material deposited on the sides of said nanoelement.

6. A structure as claimed in claim 3, including a matrix at least partially surrounding said coaxial jacket, and providing dopant ions of at least one type thereto.

7. A structure as claimed in claim 1, wherein the doping levels are such as to create degenerate doping within each of the first and second regions of the nanoelement, so that the pn junction functions as a tunnel diode.

8. A method of forming a pn junction within a one-dimensional nanoelement, the method comprising,

providing a one-dimensional nanoelement of a first semiconducting material having a first band gap,

forming an enclosure comprising at least one second material having a second band gap enclosing and in contact with said nanoelement along at least part of its length, and

doping said second material to provide opposite conductivity type charge carriers in respective first and second regions along the length of the of the nanoelement,

whereby to create in the nanoelement corresponding first and second regions of opposite conductivity type charge carriers with a pn junction therebetween by transfer of charge carriers into the nanoelement, and wherein the band gaps are such that it is energetically favorable for the charge carriers to remain in said nanoelement.

9. A method as claimed in claim 8, wherein said enclosure comprises a coaxial jacket.

10. A method as claimed in claim 9, additionally comprising providing a matrix at least partially surrounding said coaxial jacket, said matrix containing dopant ions of at least one conductivity type.

11. A method of producing a one-dimensional nanoelement of desired conductivity, the method comprising the steps of:

(1) forming a nanowhisker on a substrate by a chemical beam epitaxy method,,

(2) changing at least one condition of growth in the chemical beam epitaxy method so that a coaxial layer is formed around the nanowhisker, and

(3) introducing dopant material into the coaxial layer by a vapor phase method,

whereby charge carriers from the dopant material diffuse into the nanowhisker to create said desired conductivity.

12. A method of forming a one-dimensional nanoelement of a desired conductivity, comprising:

(a) forming a one-dimensional nanoelement on a substrate, the nanoelement being formed of a first material;

(b) forming at least a first layer of a second material on the substrate, the second material surrounding, at least partially, the nanoelement, the second material having a first conductivity type dopant material therein, and

(c) processing the second material so that said dopant material diffuses into the nanoelement, whereby to create a desired conductivity therein.

13. A method according to claim 12, wherein,

step (a) comprises forming a nanowhisker upstanding from the substrate, and

in step (b) the first layer of the second material is formed by depositing a polymer material on the substrate.

14. A method according to claim 12, wherein step (c) is a thermal annealing step to create said diffusion.

15. A one-dimensional nanoelement of a desired conductivity type formed on a substrate, comprising:

a one-dimensional nanoelement of a first material disposed on the substrate, and

at least a first layer of a second material formed on the substrate, surrounding the nanoelement at least partially and in contact with the nanoelement,

the second material having a first conductivity type dopant material therein, said first conductivity type dopant material having diffused into the nanoelement, whereby to create a desired conductivity within the nanoelement.

16. A nanoelement according to claim 15, wherein the nanoelement comprises a nanowhisker upstanding from the substrate, and the second material comprises a polymer material.

17. A one-dimensional nanoelement with at least one pn junction therein, comprising:

a nanowhisker upstanding from a substrate;

a first layer of a material formed on the substrate and surrounding the nanowhisker and extending partway up the nanowhisker,

the first layer having a first conductivity type dopant material therein; and

a second layer of material formed on top of the first layer and surrounding the nanowhisker and extending towards the top of the nanowhisker,

said second layer having a second conductivity type dopant material therein,

whereby to create a pn junction within the nanowhisker between the first and second regions , by diffusion of charge carriers or dopant ions from said first and second layers into respective first and second regions of the nanowhisker.

18. A nanoelement according to claim 17, wherein the first and second layers are formed of semiconductor materials, and charge carriers from the first and second layers diffuse into respective first and second regions of the nanowhisker, whereby to create a pn junction within the nanowhisker between the first and second regions.

19. A nanoelement according to claim 17, wherein:

the first and second layers are formed of a polymer material, and

said first conductivity type dopant material and said second conductivity type dopant material, having diffused into respective first and second regions of the nanowhisker, create a pn junction within the nanowhisker between the first and second regions.

20. A nanoelement according to claim 17, additionally comprising:

a third layer of material on top of the second layer,

said third layer of material surrounding the nanowhisker, being in contact with the nanowhisker, and extending towards the top of the nanowhisker,

said third layer of material having said first conductivity type dopant material therein, so that diffusion from said third layer into a respective third region of the nanowhisker, creates a further pn junction within the nanowhisker between the second and third regions.

21. A nanoelement according to claim 20, wherein:

the material of the third layer comprises a polymer material, and

at least a portion of the dopant material in said third layer has diffused into said third region.

22. A nanoelement according to claim 20, wherein:

the material of the third layer comprises a semiconducting material, and

charge carriers from the dopant material in said third layer have diffused into said third region.

23. A method of forming a one-dimensional nanoelement with a pn junction therein, comprising:

(a) forming a nanowhisker upstanding from a substrate,

(b) forming a first layer of material on the substrate, said first layer surrounding the nanowhisker, being in contact with the nanowhisker, and extending partway up the nanowhisker, said first layer having a first conductivity type dopant material therein, and

(c) forming a second layer of material on top of the first layer, said second layer surrounding the nanowhisker, being in contact with the nanowhisker, and extending towards the top of the nanowhisker, said second layer having a second conductivity type dopant material therein,

whereby diffusion from the first and second layers into respective first and second regions of the nanowhisker creates a pn junction within the nanowhisker between the first and second regions.

24. A method according to claim 23, wherein:

the first and second layers are formed of semiconductor materials, and

charge carriers from the first and second layers diffuse into respective first and second regions of the nanowhisker,

whereby to create a pn junction within the nanowhisker between the first and second regions.

25. A method according to claim 23, wherein:

the first and second layers are formed of a polymer material, and

said first conductivity type dopant material and said second conductivity type dopant material have diffused into respective first and second regions of the nanowhisker to create a pn junction within the nanowhisker between the first and second regions.

26. A method according to claim 25, wherein the polymer materials in said first and second layers are formed by evaporating polymer materials onto the substrate.

27. A method according to claim 25, including a step of thermal annealing to cause said diffusion of said dopant materials.

28. A method according to claim 23, additionally comprising:

(d) forming a third layer of material on top of the second layer, said third layer surrounding the nanowhisker, being in contact with the nanowhisker, and extending towards the top of the nanowhisker, said third layer of material having said first conductivity type dopant material therein,

whereby diffusion from the second and third layers into respective second and third regions of the nanowhisker creates a further pn junction within the nanowhisker between the second and third regions.

29. A method according to claim 28, wherein:

the third layer is formed of a semiconductor material and charge carriers from the third layer diffuse into a respective third region of the nanowhisker, whereby to create a pn junction within the nanowhisker between the second and third region.

30. A method according to claim 28, wherein:

the third layer is formed of a polymer material, and said first conductivity type dopant material diffuses into a respective third region of the nanowhisker, to create a pn junction within the nanowhisker between the second and third regions.

31. A one-dimensional nanoelement comprising:

a first segment of a first semiconductor crystalline material, and

a second segment of a second semiconductor crystalline material different from that of the first segment, whereby a heterojunction is formed between said first segment and second segment,

wherein the first and second materials are selected such that charge carriers of opposite conductivity type are provided at opposite sides of the heterojunction so as to create a pn junction with predetermined characteristics, which characteristics are at least partially determined by Fermi level pinning.

32. A one-dimensional nanoelement comprising:

a first segment of a first semiconductor crystalline material, and

a second segment of a second semiconductor crystalline material different from that of the first segment, whereby a heterojunction is formed between said first segment and second segment,

wherein Fermi level pinning at side facets of said first semiconductor crystalline material and said second semiconductor crystalline material determines the conductivity type of said first segment and said second segment.

33. A method of forming a pn junction comprising:

forming a one-dimensional nanoelement having a first segment of a first crystalline material, and a second segment of a second crystalline material different from that of the first segment, whereby a heterojunction is formed between said first segment and said segment ,

wherein the first and second materials are selected so as to provide charge carriers of opposite conductivity type atopposite sides of the heterojunction so as to create a pn junction with predetermined characteristics, which characteristics are at least partially determined by Fermi level pinning.

34. A method according to claim 33, wherein the nanoelement is grown as a nanowhisker by Chemical Beam Epitaxy.

35. A method according to claim 33, wherein the nanowhisker is grown under Group III-rich conditions to create an excess of Group III atoms at the surface of the nanowhisker.